WHAT IS CLAIMED IS:

1. A method for detecting a fuel leak in a compartment having at least one inlet and an exhaust outlet that is coupled in flow communication with the compartment and in flow communication with a fan, said method comprising:

determining a fan speed;

measuring a fuel leak gas concentration value;

determining a fuel leak gas concentration limit value within the compartment based on the determined fan speed;

comparing the measured fuel leak gas concentration value with the determined fuel leak gas concentration limit value; and

generating at least one of an alarm signal and a trip signal based on the comparison.

2. A method in accordance with Claim 1 wherein detecting a fuel leak in a compartment comprises detecting a fuel leak in a gas turbine compartment.

3. A method in accordance with Claim 1 wherein the fuel is natural gas and wherein measuring a fuel leak gas concentration value comprises measuring a natural gas leak gas concentration value in the exhaust outlet.

4. A method in accordance with Claim 1 wherein the outlet includes an extraction duct, and wherein measuring a fuel leak gas concentration value comprises measuring a fuel leak gas concentration value at a location within the extraction duct.

5. A method in accordance with Claim 4 wherein measuring a fuel leak gas concentration value at a location within the extraction duct comprises measuring a fuel leak gas concentration value at a location within the extraction duct determined by a computational fluid dynamics (CFD) analysis.

6. A method in accordance with Claim 4 wherein measuring a fuel leak gas concentration value at a location within the extraction duct comprises measuring a fuel leak gas concentration value at four locations within the extraction duct wherein the locations are determined based on a computational fluid dynamics (CFD) analysis.

7. A method in accordance with Claim 1 further comprising performing a CFD analysis for the compartment to correlate the fuel leak in the compartment to a measured fuel leak concentration value in the outlet based on a plurality of air flow configurations.

8. A method in accordance with Claim 7 further comprising controlling air flow configuration through the compartment with the fan speed.

9. A method in accordance with Claim 8 further comprising controlling air temperature within the compartment with the air flow through the compartment.

10. A method in accordance with Claim 7 wherein performing a CFD analysis comprises determining a quantity of air flow through the compartment based on the fan speed.

11. A method in accordance with Claim 7 wherein performing a CFD analysis further comprises determining a explosive gas concentration limit value based on at least one of a plurality of leak rates, a plurality of leak locations, a flow distribution from the at least one inlet, flow patterns within the compartment, gas concentration uniformity in the extraction duct, and a plurality of fan speeds.

12. A method in accordance with Claim 11 wherein determining a fuel leak gas concentration limit value further comprises determining a fuel leak gas concentration limit value further based on the CFD and the fan speed.

13. A method in accordance with Claim 1 wherein comparing the measured fuel leak gas concentration value with the determined fuel leak gas concentration limit value comprises:

receiving a signal proportional to the measured fuel leak gas concentration value in the extraction duct;

determining a setpoint for the fuel leak gas concentration limit value based on the fan speed; and

comparing the received signal with the determined setpoint.

14. A method in accordance with Claim 1 wherein generating at least one of an alarm signal and a trip signal comprises:

generating an alarm signal if the measured fuel leak gas concentration value exceeds the determined fuel leak gas concentration limit value by a first magnitude; and

generating an engine trip signal if the measured fuel leak gas concentration value exceeds the determined fuel leak gas concentration limit value by a second magnitude wherein the second magnitude is greater than the first magnitude.

15. A method for detecting a fuel leak in a gas turbine compartment having an inlet, an extraction duct that includes a first opening in flow communication with the compartment, and a second opening in flow communication with a fan, said method comprising:

performing a computational fluid dynamics (CFD) analysis of at least one of the inlet, the compartment, the extraction duct, the fan, at least one component within the compartment, and at least one component within the extraction duct.

determining a location for at least one fuel leak gas concentration monitor based on the CFD wherein an output signal from each fuel leak gas concentration monitor corresponds to a fuel leak pocket volume within the compartment;

determining a measured fuel leak gas concentration value in the compartment using an output signal from each fuel leak gas concentration monitor measured within the extraction duct;

determining a fuel leak gas concentration limit value for gas within the extraction duct that is proportional to fan speed, the limit based on the CFD;

comparing the measured fuel leak gas concentration value to the determined fuel leak gas concentration limit value; and

generating an alarm signal if the measured fuel leak gas concentration value exceeds the determined fuel leak gas concentration limit value by a first magnitude; and

generating a trip signal if the measured fuel leak gas concentration value exceeds the determined fuel leak gas concentration limit value by a second magnitude wherein the second magnitude is greater than the first magnitude.

16. A method in accordance with Claim 15 wherein determining a measured fuel leak gas concentration value in the extraction duct comprises measuring a fuel leak gas concentration value at four locations within the extraction duct.

17. A method in accordance with Claim 15 wherein determining a fuel leak gas concentration limit value further comprises determining fuel leak gas concentration limit value based on at least one of a plurality of leak rates, a plurality of leak locations, flow distribution from an inlet, flow patterns within the compartment, gas concentration uniformity in the extraction duct, and a plurality of fan speeds.

18. A leak detection system for detecting a fuel leak in a compartment having an inlet and an extraction duct that is coupled in flow communication with the compartment and in flow communication with a fan, said system comprising:

at least one fuel leak detector;

a software code segment programmed to:

determine a measured fuel leak gas concentration value based on an output signal from said at least one fuel leak detector;

determine a fuel leak gas concentration limit value;

compare the measured fuel leak gas concentration value with the determined fuel leak gas concentration limit value; and

generate at least one of an alarm signal and a trip signal based on the comparison.

19. A leak detection system in accordance with Claim 18 wherein the compartment comprises a gas turbine compartment.

20. A leak detection system in accordance with Claim 18 wherein the fuel is natural gas.

21. A leak detection system in accordance with Claim 18 wherein said at least one detector is positioned within said extraction duct.

22. A leak detection system in accordance with Claim 21 wherein said at least one detector is positioned in said extraction duct at a location determined by a computational fluid dynamics (CFD) analysis.

23. A leak detection system in accordance with Claim 18 wherein said fuel leak gas concentration limit value is determined using said CFD analysis.

24. A leak detection system in accordance with Claim 23 wherein said CFD analysis correlates the fuel leak in the compartment to the measured fuel leak gas concentration value.

25. A leak detection system in accordance with Claim 18 wherein a flow of air through the compartment is proportional to the speed of the fan.

26. A leak detection system in accordance with Claim 25 wherein the temperature within the compartment is proportional to the flow of air through the compartment.

27. A leak detection system in accordance with Claim 18 wherein the fuel leak gas concentration limit value is determined based on at least one of a plurality of leak rates, a plurality of leak locations, flow distribution from the inlet, flow patterns within the compartment, gas concentration uniformity in the extraction duct, and a plurality of fan speeds.

28. A leak detection system in accordance with Claim 26 wherein the explosive gas concentration limit is determined based on the CFD and the fan speed.

29. A leak detection system in accordance with Claim 18 wherein the software code segment is further configured to:

receive a signal proportional to the actual explosive gas concentration in said extraction duct;

determine a setpoint for said explosive gas concentration limit based on the fan speed; and

compare the received signal with said determined setpoint.

30. A leak detection system in accordance with Claim 18 wherein said software code segment is further configured to:

generate an alarm signal if the actual explosive gas concentration exceeds said determined explosive gas concentration limit by a first magnitude; and

generate a trip signal if the actual explosive gas concentration exceeds said determined explosive gas concentration limit by a second magnitude wherein said second magnitude is greater than said first magnitude.